World Applied Sciences Journal 38 (2): 101-105, 2020
ISSN 1818-4952

DOI: 10.5829/idosi.wasj.2020.101.105

Agronomic Performance of *Lablab purpureus* Accessions in Two Agro-Ecologies of Benishangul-Gumuz, Western Ethiopia

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Abstract: A trial was conducted to evaluate *Lablab purpureus* accessions for their agronomic traits under two agro-ecologies of Benishangul-Gumuz region, Western Ethiopia. The experiment was carried out at Assosa and Kamash forage research stations of Assosa Agricultural Research Center were purposively selected to represent mid and lowland agro-ecologies respectively. Four *L. purpureus* accessions (*L. purpureus* 147, 11609, 11640, and 6529) were evaluated in randomized complete block design with three replications. The general linear model procedures of SAS and least significance difference for data analysis and mean separation were employed respectively. Environment (E) had significant effect on plant height at forage harvesting ($P < 0.001$), forage dry matter yield ($P < 0.01$) and leaf to stem ratio ($P < 0.01$). *L. purpureus* accessions planted at Kamash had longer plant height and dry matter yielder than Assosa, however leaf to stem ratio was higher at Assosa. Genotype had no significant ($P > 0.05$) effect on forage dry matter yield, plant height and leaf to stem ratio. The interaction effect of location and genotype was also non-significant ($P > 0.05$) for all measured parameters and this suggests that performance of the accessions were stable across the locations. Therefore, it can be concluded that evaluations of yield performance and adaptation patterns of *L. purpureus* accessions in multiple environments couldn't necessary step in agronomic evaluation and selection of better adapted and high yielding species and varieties. From the evaluated *L. purpureus* accessions *L. purpureus* 6529 and *L. purpureus* 6529 accessions were slightly dry matter yielder than other accessions and they are recommended for the study area and similar agro-ecologies.

Key words: Accessions · Benishangul-Gumuz · Environment · *Lablab Purpureus*

INTRODUCTION

Ethiopia has huge livestock population. However, it was not possible to bridge the gap between the ever- increasing demand for animal products and the level of production [1]. In Ethiopia, livestock production is characterized by low productivity levels in terms of growth rate, meat production and reproductive performance. The low productivity of livestock is mainly attributed to inadequate nutrition, low genetic potential of indigenous breeds, prevalence of disease and parasites. Among these factors, under nutrition/ malnutrition is considered to be the most important limiting factors constraining animal production in Ethiopia [2, 3]. In almost all parts of Ethiopia, annual pasture grasses (54.6%) and crop residues (31.6%) are the main sources of feed in the country [4-6]. Indeed in Benishangul-Gumuz regional state natural grass land which is dominated by *Hypernia* species is the major livestock feed resource. Feedstuff of such composition, natural grass and crop residue, are insufficient to provide adequate quantity and quality of nutrient beyond maintenance requirement. Therefore, improved forage development and wise utilization of crop by-products can be minimize the problem.

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Cultivated forage crops have high yielder and better quality as compared to the natural pasture. Moreover forage legumes have high protein sources that will enhance the activity of rumen microorganisms, increase intake and digestibility when supplemented for animals consuming poor quality forages. Moreover, they can contribute to soil fertility maintenance and improvement [7, 8]. Growing of multipurpose forage legume crops like lablab through under sowing/intercropping is useful for introduction of the forage crop and to use the available small farmland for both crop and livestock feed production. Intercropping annual forage legumes with cereal crops has been proposed as a strategy to control erosion, suppress weeds and contribute biological N to companion crop [9]. Hence with this in mind, to introduce this forge species through intercropping forage development strategy, screening of the promising accessions to that environment is mandatory. The performance of forage species vary across locations due to differences in soil types, temperature and amount and distribution of rainfall. The cultivation of high quality forages with a high yielding ability, adaptable to biotic and abiotic environmental stresses is one of the possible options to increase livestock production under smallholder farmers conditions [10]. Indeed, improved forage legume crops like *Lablab purpureus* are one of the best forage legumes for animal feed and soil fertility improvement through biological nitrogen fixation.

L. purpureus is an erect, short-lived perennial herbaceous crop often grown as an annual [11]. It is preferred for good forage production, nutritional quality, and palatability. *L. purpureus* is also shade-tolerant so that it is suitable for intercropping. *L. purpureus* is drought tolerant, and has been grown in arid and semiarid regions [12]. Currently, *L. purpureus* is one of the major leguminous forage and green manure crops. However, there are no recommended *L. purpureus* accessions for their yield and agronomic performance in Benishangul-Gumuz region. Therefore, the objective of this study was to evaluate the forage dry matter yield production potential of *L. purpures* accessions and finally select and recommend the best performing accessions for use as alternative improved forage legumes in Benishangul-Gumuz regional state (BGRS), Western Ethiopia and agro-ecologies similar to the study area.

MATERIALS AND METHODS

Study Area: The trial was conducted under field conditions at Assosa, and Kamash forage research stations of Assosa Agricultural Research Center during the main cropping seasons. The test locations represent the mid and lowland areas ranging in altitude from 1000 to 1550 m.a.s.l. The farming system of the study areas is Agro pastoral. Descriptions of the test environments are indicated in Table 1.

Table 1: Descriptions of the test environments for geographical position

	Study sites	
Parameters	Assosa	Kamash
Latitude	10°30'N	09.°30'N
Longitude	034°20'E	35°45'E
Altitude (masl)	1500-1550	1000-1350
Annual rainfall (mm)	1316	1150
Daily minimum Temperature (°C)	16.75	25
Daily maximum Temperature (°C)	27.9	30

Experimental treatments and Design: The four accessions of *L. purpureus* accessions (*L. purpureus* 147, 11609, 11640, and 6529) were collected from International Livestock Research Institute (ILRI);. The accessions were planted in 3 m x 4 m plot using a randomized complete block design (RCBD) with three replications at the beginning of the main rainy season. Seed was sown by drilling in rows spaced 30 cm between rows, at a depth of 3 cm. Individual plot size was 12 m^2 and spacing between plots and replications 1.5 and 2 m, respectively at each testing environments. The treatments were sown according to their recommended seeding rates: 15-20 kg ha^{-1}.

Data Collection: Data was collected on plant height at harvesting, leaf to stem ratio and forage dry matter yield. Plant height at harvesting was taken on six plants randomly selected from each plot and measured using a steel tape from the ground level to the highest leaf. For determination of biomass yield, accessions were harvested at 10% blooming stage using a quadrant which has 1m^2 areas. Weight of the total fresh biomass yield was recorded from each plot in the field and 500 g sample was taken from each plot to the laboratory and a sub-sample of known fresh weight was oven-dried for 72 hours at a temperature of 65 °C to determine dry matter yield.

Statistical Analysis: Analysis of variance (ANOVA) procedures of SAS general linear model (GLM) was used to analyse the quantitative data [13]. LSD test at 5% significance was used for comparison of means. The data was analyzed using the following model:

$$Yijk = \mu + Gi + Ej + GEij + Bk + e\ ijk$$

where,

Yijk = Dependent variables,
μ = Grand mean,
Gi = Effect of genotype i,
Ej = Effect of environment j, j = Assosa and Kamash
Geij = Is the interaction effect of genotype i and environment j
Bk = Effect of block k, and
eijk = Random error effect of genotype i, environment j, interaction effect of genotype i and environment j, and block k.

RESULTS AND DISCUSSION

Environment and Interaction Effect on *L. Purpureus* Accessions Performance: Combined analysis of variance for measured agronomic traits of *L. purpureus* accessions tested over environments is presented in Table 2. Environment (E) had significant effect on plant height at forage harvesting ($P < 0.001$), forage dry matter yield ($P < 0.01$) and leaf to stem ratio ($P < 0.01$). This variation might be due to differences among the testing environments in altitude, soil types, temperature and differences in both amount and distribution of annual rainfall and other agro-climatic factors. Findings from this experiment agree with reports of [14] who findings reveal that location significantly affect the forage dry matter yield of *L. purpureus* cultivars studied for herbage yield. Genotype (G) and G x E (genotype by environment interaction) had no significant ($P > 0.05$) effect on plant height at forage harvesting, leaf to stem ratio and forage dry matter yield. This suggests that performance of the accessions were stable across the locations. This implies that, evaluations of yield performance and adaptation patterns of *L. purpureus* genotype in multiple environments couldn't necessary step in agronomic evaluation and selection of better adapted and high yielding species and varieties.

Leaf to Stem Ratio: The leaf to stem ratio at forage harvesting of tested *L. purpureus* accessions is indicated in Table 3. Environment had significant ($P < 0.01$) effect on leaf to stem ratio. The higher leaf to stem ratio was obtained from the mid-altitude (Assosa) than lowland altitude (Kamash) and this might be due the function of the longer periods of physiological growth of plants in high altitude/cooler environment with increase defoliation frequency stimulating leaf growth at the expense of stem production. The leaf to stem ratio has significant implications on the nutritive quality of the forage as leaves contain higher levels of nutrients and less fiber than stems. The result indicated that the leaf to stem ratio is an important factor affecting diet selection, quality and intake of forage [15]. The leaf to stem ratio is associated with high nutritive value of the forage because leaf is generally of higher nutritive value [16] and the performance of animals is closely related to the amount of leaf in the diet. Therefore, according to the report of these authors the *L. purpureus* genotypes grown at Assosa is more nutritious than *L. purpureus* genotypes grown at Kamash due to the leaf to stem ratio was higher at Assosa than Kamash. The result of combined and each locations analysis showed that leaf to stem ratio was non-significant ($P < 0.05$) among the accessions.

Plant Height at Forage Harvesting: Summary analysis of variance for the performance of different *L. purpureus* accessions on plant height at forage harvesting was given in Table 4. The result of this study revealed that testing environment significantly ($P < 0.001$) affect plant height at forage harvesting and higher value of plant height at forage harvesting recorded at Kamash. This might be associated to the difference in environmental condition such as rainfall, soil fertility, temperature. Although, the result could be due to the Assosa soil is more acidic (PH > 5.5) than the Kamash soil (PH < 5.5) and this leads to plant root growth which result stunted and reduced

Table 2: Combined analysis of variance for measured agronomic traits of four *L. purpureus* accessions tested in two agro-ecologies of Benishangul-Gumuz Regional State

	Mean square				
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Traits	Genotype	Environment	G X E	Mean	CV
Plant height (cm)	ns	***	ns	145.21	44.09
Forage DM yield (t/ha)	ns	**	ns	4.34	36.89
Leaf to stem ratio	ns	**	ns	0.67	46.87

G x E=Interaction of genotype and environment; CV= coefficient variation; ns= non significant ($P > 0.05$); ***= $P < 0.001$; **= $P < 0.01$; *$P < 0.05$.

Table 3: Mean leaf to stem ratio of four *L. purpureus* accessions tested in two agro-ecologies of Benishangul-Gumuz Regional State

Accessions	Location/Environments Assosa	Kamash	Combined analysis
L. purpureus 147	0.75	0.50	0.58
L. purpureus 11609	0.86	0.46	0.59
L. purpureus 6529	0.79	0.63	0.68
L. purpureus 11640	0.74	0.62	0.66
Mean	0.79[a]	0.55[b]	0.63
CV	29.12	32.63	52.33
P-value	ns	ns	ns

CV= coefficient variation; ns= non significant (P > 0.05); [a, b] = show significance difference between the location

Table 4: Mean plant height at forage harvesting (cm) of four *L. purpureus* accessions tested in two agro-ecologies of Benishangul-Gumuz Regional State

SN	Accessions	Location/Environments Assosa	Kamash	Combined analysis
1	*L. purpureus* 147	114.75	172.20	153.05
2	*L. purpureus* 11609	95.92	170.69	145.77
3	*L. purpureus* 6529	145.42	194.05	177.84
4	*L. purpureus* 11640	102.00	166.65	145.10
	Mean	114.52[b]	175.90[a]	155.44
	CV	32.47	28.00	44.51
	P-value	ns	ns	ns

CV= coefficient variation; ns= non significant (P > 0.05); [a, b] = show significance difference between the location

Table 5: Mean forage DM yield (t/ha) of four *L. purpureus* accessions tested in two agro-ecologies of Benishangul-Gumuz Regional State

SN	Accessions	Location/Environments Assosa	Kamash	Combined analysis
1	*L. purpureus* 147	3.40	4.38	4.06
2	*L. purpureus* 11609	3.27	4.98	4.41
3	*L. purpureus* 6529	4.36	5.59	5.18
4	*L. purpureus* 11640	3.90	4.81	4.51
	Mean	3.73[b]	4.94[a]	4.54
	CV	27.68	36.57	36.76
	P-value	ns	ns	Ns

CV= coefficient variation; ns= non significant (P > 0.05); [a, b] = show significance difference between the location

growth rate in plants at Assosa. The result of combined and each location analysis showed that plant height at forage harvesting was not significantly (P > 0.05) different among the tested genotypes.

Forage Dry Matter Yield: The mean forage dry matter yield of four tested *L. purpureus* accessions presented in Table 5. The result of this study showed that forage dry matter yield of *L. purpureus* was significantly (P < 0.01) different among locations/testing environment. *L. purpureus* genotypes grown at Kamash were more yielder than *L. purpureus* genotypes grown at Assosa. This might be due to the leaf stem ratio of the tested *L. purpureus* accessions was higher at Assosa than Kamash. As the leaf to stem ratio becoming increase, the forage dry matter yield becoming decrease, however the nutrient content will be increase and this might be due the leaf part of the forage is more nutritious than stem. Although, the result might be due to the forage dry matter yield is directly related to plant height at forage harvesting stage, because when the plant height at forage harvesting increases forage dry matter yield also increase. The result of combined and each location analysis showed that forage dry matter yield did not significantly (P > 0.05) affected by genotypes. Comparable value of herbage dry matter yield (4.54 t/ha) compared to this study result was reported by Bikila Negasa, Bedasa Eba and Jaldessa Doyo [17] who studied three accessions of *L. purpureus* (*L. purpureus* 11614, 147 and 11640) for their adaptation performance under the semi-arid environments o f Borana zone.

CONCLUSION

The environment can affect plant height at forage harvesting, leaf to stem ratio and forage dry matter yield of *L. purpureus*. Lowland altitude could be most favorable agro-ecologies than mid-altitude for *L. purpureus* since the plant height and forage dry matter yield is high at lowland agro-ecologies. The interaction effect of location and genotype was non-significant for all measured parameters and this suggests that performance of the accessions were stable across the locations. Therefore, it can be concluded that evaluations of yield performance and adaptation patterns of *L. purpureus* genotype in multiple environments couldn't necessary step in agronomic evaluation and selection of better adapted and high yielding species and varieties.

ACKNOWLEDGEMENT

The authors are grateful to Ethiopian Institute of Agricultural Research for financial support and Assosa Agricultural Research Center staffs specially Livestock Research Process for their honesty and hearty assistance.

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